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A SIMULATION STUDY
OF ORGANIZATIONAL DECISION MAKING
UNDER CONDITIONS OF UNCERTAINTY AND AMBIGUITY

by

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A Simulation Study of Organizational Decision Making Under Conditions of Uncertainty and Ambiguity

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ABSTRACT

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I. INTRODUCTION

Until recently, the theory of organizational decision making has been dominated by the concept of rationality. The popularity enjoyed by operations research, systems analysis, and decision theory did much to further this school of thought. According to the model, a single decision maker, acting under a set of consistent goals and preferences, identifies as many courses of action as possible, weighs these alternatives in a cost-benefit framework, and then selects the option that optimizes the attainment of predetermined objectives. [Ref. 1, Ref. 2, Ref. 3, Ref. 4, Ref. 5]

The theory of "rational man" acting in a decision situation assumes 1) that a single decision maker is involved, 2) that the consequences associated with each alternative can be anticipated, and 3) that the decision maker is well aware of his goals and able to develop a preference scale to choose among alternatives. Although such an approach can provide certain insights into the decision making process, the practical use is restricted to a small subset of decision situations, primarily ones characterized by simplicity, stability, and certainty. As Charles Lindblom has said about the rational approach:

> It assumes intellectual capacities and sources of information that men simply do not possess, and it

is even more absurd as an approach to policy when the time and money that can be allocated to a policy problem is limited, as is always the case. [Ref. 6: p. 80]

Alternate approaches to organizational decision making were presented as early as 1938 by Chester Barnard in his book The Functions of the Executive. Herbert Simon, James March, Richard Cyert, Charles Lindblom, and Graham Allison all had a significant impact in providing an awareness to the limitations of the rational model, while providing new ideas contributing to the understanding of the decision making process.

Simon, in Administrative Behavior, proposed the concept of satisficing, emphasizing "bounded-rationality", where decision makers aim to find satisfactory options rather than concern themselves with search and selection of optimal alternatives. [Ref. 2]

Lindblom in a Public Administration Review article, Cyert and March in A Behavioral Theory of the Firm, and Allison in an American Political Science Review article, all approached the view of decisions as an output of standard operating procedures found within an organization--in general, known as the organizational procedures or process view. [Ref. 6, Ref. 7, Ref. 1] Allison also recognized the importance of power and bargaining procedures within the decision arena, and this framework was described as the bureaucratic political view of decision making. [Ref. 1]

Although the importance and relevance of these "non-rational" models cannot be underestimated, there still remained a great deal of organizational behavior which did not fit well into any of these frameworks. In 1972, Cohen, March, and Olsen presented an article in Administrative Science Quarterly entitled "The Garbage Can Model of Organizational Choice". Building on the previously discussed decision frameworks, the article presented a model attempting to represent some of this unexplained organizational behavior. Specifically, the model addressed organizations facing uncertainty and ambiguity, where goals were ill-defined, decision methodology undeveloped, and decision makers inconsistent in their attention to organizational decisions and problems. The garbage can model, as discussed in the article and in subsequent books, was associated primarily with educational institutions. [Ref. 8, Ref. 9, Ref. 10, and Ref. 11]

The potential application of this model to a broad base of organizational types began to take form when a framework for studying military decision making was sought during this particular research endeavor. Although analysis of decision making in combat has been entrenched in rationality, astute military authors have conceded that much uncertainty and ambiguity faces even the most proficient military commanders. Writing in Masters of the Art of Command, Blumenson and Stokesbury introduce their study of great

military leaders through the years with the following sobering viewpoint:

> The skills of the soldier and the officer, of the newest "military manager" of modern armies, are not startlingly different from those of Sulla, the most ancient in this collection. . . . all the forces that he can command are still at the mercy of all the forces he cannot command. [Ref. 12: p. 38]

Karl von Clausewitz, one of the greatest military philosophers of all time, had a similar thought:

> We thus see that the absolute, the so-called theoretical, faculty finds nowhere a sure basis in the calculations of the art of war. From the outset there is a play of possibilities and probabilities, of good luck and bad, which permeates every aspect of war, great or small, and makes war, of all branches of human activity, the most like a game of cards. [Ref. 13: p. 80]

The garbage can's preconditions of ill-defined goals (called problematic preferences in the model), undeveloped decision methodology (known as unclear technology), and inconsistent decision maker attention (described as fluid participation) are well-documented in military history:

--Problematic Preferences: Field Marshal Rommel of the German Army in World War II was noted for not carrying any fixed plans into battle other than those necessary for initial confrontation with the enemy, and tailoring his tactics to meet the threat as it occurred, [Ref. 14];

--Unclear Technology: Observations have been made that military organizations are "notorious in their penchant for the strategy of the last war" [Ref. 15: p. x], thereby having to develop new approaches on the spot to deal with an advancing enemy;

--Fluid Participation: Certainly battlefield casualties and communication failures lead to conditions of inconsistent attention to decision situations.

Therefore, a seemingly disparate philosophy and model of decision making is, in fact, very representative of the intricate circumstances faced by the military decision maker in combat.

Investigation into other organizational settings provided additional applications of this dynamic and flexible model. In the foreign policy arena, the United States' entrance into the Korean Conflict, the Cuban Missile Crisis, and the prelude to the Arab-Israeli wars of 1967 and 1973, provided evidence that a theory of decision making under ambiguity was indeed relevant. Similar crises circumstances in the business world, specifically the Allied Crude Vegetable Oil and Refining Company scandal of 1963 which rocked the New York Stock Exchange, demonstrated further the far-reaching potential of the garbage can model to provide insight into numerous facets of organizational decision making.

The thrust of this research effort was to enhance the garbage can model, specifically by modification of the FORTRAN simulation presented in the original Cohen, March, Olsen article, incorporating attention mechanisms like triggering (Chapter III) and deadlines (Chapter IV), as well as studying the effect of dynamic system load changes (Chapter V) and organizational structural adaptations (Chapter VI).

The premise for this approach was to begin with a relatively simple model, and to build in an evolutionary manner a more elaborate extension of this model to include certain aspects of complex situations commonly found by military, business, and political organizational systems. The overriding aspiration was to achieve what James Miller experienced in his study of information overload, presented in Living Systems:

> Begin a basic research, and your subject matter ramifies in many directions. A large number of new questions arise. Begin with a basic research and ultimately practical applications commonly appear. [Ref. 16: p. 195]

II. THE GARBAGE CAN MODEL

A. VERBAL MODEL

1. Overview

The garbage can model has been selected for study and adaptation based on two observed characteristics of organizational systems. First, critical decisions in any type of organization, whether it be military, industrial, or political, often are made during times of complexity, instability, and ambiguity, the very environment the garbage can models. Secondly, decisions within an organization are not made in isolation. At any point in time, there are numerous decision situations, decision makers, organizational problems, and potential solutions interacting in a manner not thoroughly addressed in other models of decision making. This intricate interaction causes the organizational system to be driven by problem and solution flows, rather than by the decision process itself.

Although often associated with educational institutions and "exotic" organizations [Ref. 17: p. 295, Ref. 9, Ref. 10, Ref. 8, and Ref. 11], examination of business, military, and political decision making testifies to the relevance of this model to a broader range of organizations, even ones historically described as well-structured and unambiguous.

A brief overview of the original model and associated simulation will provide the necessary framework for discussion of adaptations and modifications to the model presented in this paper.

In the purest sense of the model, an organization should exhibit three properties, considered preconditions to the operation of garbage can-like decision processes. One could argue convincingly, however, the model is robust in describing organizations with only one or two of these characteristics. The three attributes of an "organized anarchy" are problematic preferences, where goals are confused and obscure, or where they are defined but not widely agreed upon; unclear technology, where trial and error or creative decision processes become the basis for choice due to consequences of prior organizational action; and fluid participation, where decision makers are recognized as having limited attention, time, and energy to devote to specific issues, thereby causing discontinuities and instabilities within decision situations.

The theory of the garbage can model focuses on two primary attributes of the decision process: decision maker attention, and flows and timing of decisions, problems, and solution alternatives within an organization. [Ref. 18, Ref. 11, and Ref. 19]

2. Decision Maker Attention

Every organizational decision maker must answer the questions: To what decisions should I apportion my

time and effort? When is the optimal time to work on certain problems? How should I prioritize my activities? Under ambiguous conditions, the answers to these questions are not easily ascertained. Therefore, the decision maker is faced with having to satisfice his decisions, based on his limited ability to provide attention to choice situations. The garbage can models attention distribution through organizational structures, decision maker energy distributions, and the time availability of decision situations, problems, and alternatives. Further investigation into attention mechanisms, as presented in this paper, provide further insight into this concept.

3. Flows and Timing

The more traditional theories of decision making view the ordering of the process as follows: problems emerge, a decision situation is created to address these problems, and then alternatives are sought to solve the problem. In the garbage can, decisions situations, problems, and alternatives all circulate, to a large extent, independent of one another, although decision makers do have the ability to bring problems and alternatives with them to choice opportunities. This relative independence permits problem alternatives to arrive at choice situations prior to the problem itself, as well as problems and alternatives seeking decision situations in which to enter. The matching of solutions to problems, thereby solving organizational difficulties is largely determined by

sequencing and timing, as decision processes' components are introduced to the system.

4. Key Definitions

Four expressions are central to the model: choice, problem, solution, and participant. They deserve an explanation as to their meaning and significance.

A choice situation provides the potential arena for a decision to be made. The outcome of a choice situation may, or may not, be a decision. Even if a decision is produced, few or none of the attendant problems may be resolved. A choice is characterized by its activation time, the decision maker's eligibility and actual participation in the process, and the organizational problems and potential solutions brought for consideration.

Problems are those issues, when properly resolved, that normally improve the efficiency or effectiveness of some segment of the organization. Disposing of the right problems may lead to victory in combat, a competitive advantage in business, or a peaceful compromise in international relations. Problems, in the garbage can model, exist independent of choices, and depending on the structural limitations of the organization, have varying degrees of free access into available choice situations. Problems are characterized by the time they enter the organizational system, the relative effort needed to resolve them, and the available choice situations they may penetrate.

Solutions are decision alternatives with the potential, if properly matched, to dispose of problems. Solutions are similar to problems in that they have a time dependent flow through the organization, and have the opportunity to influence multiple choice situations. In the garbage can, solutions are not discovered or created in response to a specific problem or choice situation. They are independent of both, and how they flow into the system will be a prominent factor as to how well problems are resolved.

The decision makers who provide the time, energy, and attention within a choice situation are considered to be the garbage can participants. They are characterized by the force they apply toward decision making and problem solution, and their ability to become involved, as defined by the organizational circumstances, in a specific choice situation. The model concerns itself less with the individual characteristics of the participants, i.e., their personality, background, perspective, and their aggregate effect and interaction with the other organizational elements.

Although the use of metaphors in describing organizational phenomenon has been criticized for its imprecision [Ref. 20], viewing the decision process in an organized anarchy as a garbage can has its merits. The cans of the model represent the various choices available for the disposition of refuse--the problems, solutions, and participants. As the process progresses through time,

some garbage is moved from one receptacle to another, other garbage is ejected, and the remaining garbage continues to mix in the containers. The operation of the model, as communicated by the simulation, closely resembles this sanitation procedure.

B. SIMULATION

1. Specifications

The FORTRAN simulation, as presented in the original garbage can article [Ref. 10], functions based on the following specifications:

1) A set of fixed parameters--A limited number of participants (10), choices (10), and problems (20), are allowed to enter the organizational sphere of influence. Twenty time periods are provided for the interaction of the preceding elements.

2) Entrance requirements--The 10 participants remain in the decision arena for all 20 time periods. Choices enter the system one per time period for the initial 10 time periods, and are deactivated when a choice is made (how a choice is "made" will be described below). Problems enter the system two per time period for the initial 10 time periods, and similarly disappear when solved (how problems are "solved" also is discussed below). Solutions are modeled in the simulation, but for ease of execution, as

a solution coefficient, ranging between 0 and 1, rather than as a flow of specific solutions. This coefficient can vary from time period to time period, or be fixed for the entire process.

3) Structural definitions--All organizations have rules and procedures, written and unwritten, formal and informal, providing control over decision maker involvement and the ability of organizational issues to be addressed within a specified choice situation. The garbage can models these organizational restraints with the use of decision and access structures.

The decision structure regulates the ability of decision makers to attend to available choices. Although eligible to participate in a choice situation, as delineated by the decision structure, this does not imply the decision maker must become involved in that particular decision, only an invitation is offered.

Three decision structures are simulated in the garbage can: unsegmented, hierarchial, and specialized. The matrix composition of each of these structures is represented in each of the tables which follow, where the numeral one in a particular position means the participant has access to the associated choice, and a restriction is represented by a zero. For discussion purposes, choices and participants are ranked from most to least important, as the participant and choice number increases from one to ten.

In the unsegmented decision structure, Table I, all participants may access all choices. This could model the top decision makers in an organization (for example, in the military context, the Flag Commander, Chief of Staff, and Operations Officer, who together may access numerous choice situations).

TABLE I

UNSEGMENTED DECISION MATRIX

Participant Number	Choice Number									
	1	2	3	4	5	6	7	8	9	10
1	1	1	1	1	1	1	1	1	1	1
2	1	1	1	1	1	1	1	1	1	1
3	1	1	1	1	1	1	1	1	1	1
4	1	1	1	1	1	1	1	1	1	1
5	1	1	1	1	1	1	1	1	1	1
6	1	1	1	1	1	1	1	1	1	1
7	1	1	1	1	1	1	1	1	1	1
8	1	1	1	1	1	1	1	1	1	1
9	1	1	1	1	1	1	1	1	1	1
10	1	1	1	1	1	1	1	1	1	1

A hierarchial structure, Table II, is the one most commonly associated with bureaucratic organizations. Top decision makers have access to many choices, whereas decision makers down the organization have more limited access. Again considering the military environment, this could represent a commanding officer at the top of the organizational pyramid having the potential to be involved in numerous decision situations, whereas subordinates down the chain-of-command are more restricted.

TABLE II

HIERARCHIAL DECISION MATRIX

Participant Number	Choice Number									
	1	2	3	4	5	6	7	8	9	10
1	1	1	1	1	1	1	1	1	1	1
2	0	1	1	1	1	1	1	1	1	1
3	0	0	1	1	1	1	1	1	1	1
4	0	0	0	1	1	1	1	1	1	1
5	0	0	0	0	1	1	1	1	1	1
6	0	0	0	0	0	1	1	1	1	1
7	0	0	0	0	0	0	1	1	1	1
8	0	0	0	0	0	0	0	1	1	1
9	0	0	0	0	0	0	0	0	1	1
10	0	0	0	0	0	0	0	0	0	1

The specialized structure, Table III, severely limits the access of all participants. Decision makers only attend to a choice falling in their own area of expertise. The individual members of a military staff (Intelligence Officer, Logistics Officer, Administrative Officer, etc.) would often operate under this arrangement.

The relational possibilities for problems to choices is exactly analagous. Termed access matrices, the simulation provides for unsegmented, hierarchial, and specialized access of problems to choices. As previously mentioned, solutions conceptually could be organized in a similar manner, but for simplification, are modeled as a single coefficient.

The simulation results are heavily dependent on the organizational structures specified, and we come to find

TABLE III

SPECIALIZED DECISION MATRIX

Participant Number	Choice Number									
	1	2	3	4	5	6	7	8	9	10
1	1	0	0	0	0	0	0	0	0	0
2	0	1	0	0	0	0	0	0	0	0
3	0	0	1	0	0	0	0	0	0	0
4	0	0	0	1	0	0	0	0	0	0
5	0	0	0	0	1	0	0	0	0	0
6	0	0	0	0	0	1	0	0	0	0
7	0	0	0	0	0	0	1	0	0	0
8	0	0	0	0	0	0	0	1	0	0
9	0	0	0	0	0	0	0	0	1	0
10	0	0	0	0	0	0	0	0	0	1

under ambiguous conditions, these administrative practices help to prevent "unexpected" participants or problems arriving at choice situations--the structures, therefore, begin to add some order to an otherwise anarchial state.

4) Energy factors--Energy in the simulation is associated with participants and problems, reflecting the ongoing competition between the decision maker's time, attention, motivation, experience and abilities, and the activated problems' complexity, novelty, and difficulty [Ref. 19].

Numerically, the participants are provided with 5.5 units of energy per time period. This energy may be distributed in three different ways: the case where the most important decision maker has the least energy to provide per time period (.1) and the least important decision maker has the most (1.0), with the intermediate decision makers

having increasing energy going from the top of the organization down; the case where all ten decision makers have equal energy per time period (.55); and the case where the most important decision maker has the most energy per time period (1.0) and the least important decision maker adds little energy per time period (.1), with intermediate decision makers having increasing energy going from bottom to top.

To determine which distribution best models a given organization, one would have to examine the boundaries of analysis. When simulating a closed system embedded in an open system, where top decision makers must devote a significant amount of energy and attention outside the simulated portion of the organization (for public relations, governmental liaison, etc.), the first energy allocation scheme, where the most important decision maker has less energy, might be considered most appropriate.

When simulating a strictly closed system, where one is only studying the internal interactions of an organization (i.e., outside demands are ignored because they are the same for all decision makers) it is perhaps most appropriate considering the top decision maker with the most energy, distribution scheme three. Although the energy demand is great on the top leadership of the organization in this situation, their experience and knowledge is far-reaching, thus enabling them to make up

for a lack of attention, by the use of their developed talents.

In the most general case, scheme two, equal energy for all participants is fitting. One might view this condition where the less important decision makers can add raw energy to a decision situation by the time they can devote, and the most important decision makers add the refined energy of experienced judgment in short spurts of attention to assist in bringing a decision to closure [Ref. 21].

Problems bring energy requirements to choice situations as well, and it is this energy which must be overcome in order for a choice to be made. Under a given load condition (light, moderate, or heavy), each of the 20 problems carry the same energy requirement--1.1, 2.2, 3.3 respectively. The original model does not allow for problems to become more difficult within a 20 time period run. Modeling this dynamic change was one of the modifications performed in this study. Results of the modification will be presented in a subsequent section.

5) Participant and problem assignments--Another critical issue of the simulation is how problems and participants flow to choice situations. Assuming a participant or problem has the necessary credentials to enter a choice situation (as determined by the decision and access matrices), the final assignment (in a particular time period) will be

to that choice nearest completion. Problems and participants will therefore attend to decision situations with the highest expected return [Ref. 11]. This method of assignment highlights the importance of what else is happening in the organizational system when a participant decides where to devote attention. In addition, each activated problem and participant must be attached to one choice per time period, unless there are no choice situations to which they have access.

6) Choice execution--Central to the simulation's operation is the making of choices and the solution of problems. A choice is made when the energy as derived from the energy distribution and solution coefficients, accumulated over all time periods, summed over all decision makers having attached to the choice, is greater than or equal to the total energy solution requirement of the problems presently at the choice. This calculation is performed for every active choice, every time period.

Problems are solved only when they are attached to a consummated choice. This is termed decision by resolution. Organizations would prefer all choices to be made in this manner. In the garbage can, however, choices also may be made by flight or oversight, and simulation results show these to be the primary methods of decision making, especially under moderate or heavy loads.

Oversight decision making is done quickly and efficiently on certain choices as they enter the system, without regard to

any associated organizational problems. In the simulation, this occurs when participants move to a choice situation, but for various reasons no problems attach to the choice. One time period worth of participant's energy will be sufficient to make the choice.

Decisions by flight occur when problems have been attached to a choice for some time, preventing the completion of the choice, but subsequently all move into other decision situations allowing the remaining participants to make the choice--again solving no problems.

2. Results and Implications

The simulation is exercised by having the six aforementioned elements (fixed parameters, entrance requirements, structural definitions, energy factors, participant and problem assignments, and choice execution) interact, permitting observations to be made and conclusions to be drawn about system decision making in an organization facing an environment where the three preconditions of the model hold true. The simulation runs through 81 different organizational combinations: three types of loads (light, medium, heavy), three types of decision structures (unsegmented, hierarchial, specialized), three types of access structures (unsegmented, hierarchial, specialized), and three types of energy distributions (as described in the energy factors section).

A number of implications about garbage can-like decision processes were drawn from the statistical results emanating from the original simulation runs [Ref. 8]. Four of these observations will be highlighted as being significant in their relationship to modifications investigated in this study.

1) Few choices are not made, but most problems go unsolved. Considering the 81 organizational variants, the mean number of choices not made was 1.0 (out of 10), whereas the mean number of problems not solved was 12.3 (out of 20). The principal reason for this is the majority of choices are made by flight or oversight, solving no attached problems. Most choices can be made only when they first enter without having problems attached, or subsequently when unburdened as problems seek new choice situations. This result stands in direct opposition to the normal theoretical view that decision making is a process for solving problems. Further discussion about studies in optimal structures for problem solution is presented in the chapter entitled Dynamic Structural Change.

2) The load on the system has dramatic effects on the decision makers' ability to achieve profitable results. In general, as one looks across similar structures under light, moderate, and heavy loads, choice resolution and problem solution become much more difficult under moderate and heavy loads. The chapter on load variations discusses the effects

on the system when load is not kept constant during the 20 time periods, but increases from a light to a heavy load, an environment faced by military units in combat, and business and political organizations in times of crisis.

3) Decision makers and problems have a repeated tendency to migrate from choice to choice in mass when not restricted by access or decision structures. This result tends to explain why decision makers feel as if they are working on the same problem time and time again. This mass migration is discussed further in the chapter on Triggering.

4) Under hierarchial structures, where important and unimportant choices can be differentiated, important choices (choices one through five) normally are ineffective in resolving problems, whereas unimportant choices (choices six through ten) become a receptacle where problems have a better chance of being solved. This is due to the fact that flight and oversight are the primary means to make important choices. The chapter on Deadlines addresses how this situation can be improved with administrative control mechanisms.

In Ambiguity and Choice in Organizations, March and Olsen succinctly summarize the phenomena of decision making under ambiguous conditions:

> The garbage can process, as it has been observed, is one in which problems, solutions, and participants move from one choice opportunity to another in such a way that the nature of the choice, the time it takes, and the problems it solves all depend on a relatively complicated intermeshing of the mix of choices available at any one time, the mix of problems that have

> access to the organization, the mix of solutions looking for problems, and the outside demand on the decision makers. [Ref. 11: p. 36]

Although the process leads to an organizational situation whose actions and results are difficult to predict, and whose decision makers have limited control over their decision making circumstances, the garbage can does allow decisions to be made and some problems to be solved, even when the organization confronts uncertainty and complexity. For many organizations, like the military in combat and businesses in crises, this model should provide insight and even some hope.

III. TRIGGERING

A. DISCUSSION

The first area investigated in the framework of the garbage can model was the phenomenon of triggering. Although described by varying names (stimuli, source mechanisms, decision activations, interruptions), the concept of environmental changes evoking decision situations is found in the organizational writing of Barnard, Sayles, and Mintzberg [Ref. 22, Ref. 23, Ref. 24], as well as in various political science literature [Ref. 25, Ref. 27, Ref. 28]. Mintzberg's study, in particular, highlighted the characteristic work environment faced by the organizational decision maker. He observed managers being constantly triggered by numerous and diverse stimuli, resulting in limited attention to any one matter, cursory examination of many problems, and the burden of a heavy workload.

Triggering, therefore, will have a significant impact as to which decision situations are created, and which problems are attended to. As the garbage can model focuses on attention, flows, and timing, the aggregate effect of triggering should be observed in the simulation. The extent to which this statement is true will be discussed in the section on triggering simulation results.

It is instructive at this point to present a brief overview of where triggers originate, how decision makers

respond to these triggers, and how this process affects their decision making and overall approach to their responsibilities.

1. Sources of Triggers

Barnard claims in The Functions of the Executive that occasions for decisions emanate from three sources: superiors, subordinates, and the initiative of the individual decision maker [Ref. 22]. In his study of administrative behavior, Sayles parallels this thought with four more general sources of stimuli: contacts initiated to the manager, contacts initiated from the manager, observations by the manager, and numerical records [Ref. 23]. Whatever the sources--and they are many and varied--both inside and outside the organization the decision maker faces an inordinate number of daily contacts [Ref. 23].

One might imagine that the majority of these triggers are precise and explicit, but in actuality, many are implicit and ambiguous. A superior may use an implicit triggering process to test the alertness or dedication of a subordinate, or he may use this method to avoid a direct order. A striking example of the latter occurred in the 1973 Yom Kippur War, when Moshe Dayan (Israeli Defense Minister) consistently presented what was known as "ministerial advice" to his commanders in the field. Although Dayan was to later emphasize that these were not direct orders, they regularly were construed as such, and the military commanders

responded to the "advice" with meetings, radio contacts to their subordinates, etc. [Ref. 29].

2. Responses to Triggers

Perhaps more important than the source of triggering, is how decision makers respond to these triggers, and the associated effects on their decision making process. The response is well-described by Mintzberg, as he compares the manager to a juggler:

> At any one point in time he has a number of balls in the air. Periodically, one comes down, receives a short burst of energy, and goes up again. Meanwhile, new balls wait on the sidelines and, at random intervals, old balls are discarded and new ones added. [Ref. 24: p. 81]

Decision makers quickly and dutifully attend to triggers coming from all directions. They are perfectly willing to split their attention among numerous choice opportunities rather than dedicating themselves for too long to one situation.

The primary impact of this regimen is the emphasis by decision makers on the immediate, the tangible, and the urgent. This is often at the expense of the vital priorities of the organization or the opportunity to use their valuable time for planning and contemplation of critical issues. There appears to be little attempt to differentiate the frivolous from the meaningful.

Basically, the largely futile attempts at differentiation are accomplished through what could be considered the individual decision maker's "filtration system",

characterized by the perceptions he or she brings to the situation, a cursory examination of the information's source, and the way the information entered the system [Ref. 15, Ref. 28, Ref. 26].

An example of this process in action took place prior to the Korean Crisis of 1950, when the United States Ambassador to South Korea sent a cable to the State Department about the heavy buildup of North Korean troops along the 38th parallel. This information should have triggered the executive branch into a decision situation, but because of (1) the perception that the Soviet Union would not back such an invasion into Korea, and (2) the source of the information--a diplomat who was known to be building a case for more military and economic aid to South Korea--the triggering did not occur until the invasion of South Korea actually took place [Ref. 26]. Although this "system" is in place, observation of organizational decision making shows it to be largely ineffective in preventing decision making by fragmentation.

3. <u>Control of Triggers</u>

Is there evidence organizations and decision makers make a concerted effort to control triggering and therefore add more consistency and regularity to their existence? Organizations as a whole, attempt to control triggering by the use of filtering devices like staffs, executive assistants, and secretaries, as well as stressing formal

lines of communication and time management techniques to prevent interruptions. The relative failure of these control mechanisms, however, can be attributed to the individual decision maker's unwillingness to ignore the triggers which govern his workday. Mintzberg found indicators that decision makers actually prefer the type of hectic environment described previously, and feel uncomfortable when it does not exist [Ref. 24: p. 34]. When triggering is limited, the decision maker begins to search the environment actively, observing, inspecting, questioning associates, subordinates, and key intelligence sources, internal or external to the organization. Decision makers thrive on this active flow of information, primarily in the form of verbal media, i.e., face-to-face contacts, meetings, and telephone calls [Ref. 30: p. 52].

4. Examples of Triggering

Military, organizational, and foreign policy history are replete with examples of triggering. In the foreign policy arena, prior to the 1967 Arab-Israeli War three major stimuli created choice situations for the Israeli Government: (1) On 15 May 1967, Egyptian troops were moved through Cairo on their way to the Suez; Prime Minister Eshkol responded by meeting with the Chief of Staff of the Israeli Defense Forces, and they decided to alert the Regular Army. (2) On 22 May 1967, Egypt closed the Straits of Tiran to shipping; the Israeli cabinet met and initiated

a large scale mobilization. (3) On 30 May 1967, King Hussein of Jordan arrived in Cairo and signed a defense agreement with Nasser; Eshkol sent his intelligence head to ascertain the position of the United States in this situation, and subsequently the Israeli leadership solidified their battle plans, leading to the 1967 war [Ref. 27].

Similar reactions to occuring events, creating meetings, discussions, personal contacts, and eventual decisions, can be seen in the business world as crises are experienced. The 1963 Allied Crude Vegetable Oil and Refining Company scandal is an example demonstrating how the Board of Governors of the New York Stock Exchange was triggered into decision situations as the scandal began to unfold [Ref. 31].

This same triggering behavior was visible in the Korean Crisis of 1950, the Cuban Missile Crisis, and numerous decisive battles through time [Ref. 25, Ref. 32, Ref. 33, Ref. 34, Ref. 35].

Triggering is a significant characteristic of any organization, and a decision making model representing any part of organizational reality must in some way address this mechanism.

B. SIMULATION MODIFICATIONS

To determine whether the original garbage can simulation realistically modeled triggering, as described in the previous section, a detailed analysis was performed on the

stream of choices entering the system one per time period for the first ten periods, how decision makers responded as these choices entered the system, and whether there was evidence of fragmented attention to choice situations. After completing this investigation, it became apparent the original simulation performed enviably in representing this triggering phenomenon. Since the garbage can model is approaching decision making from a systems view, it did not address who was doing the triggering, or how the triggers were creating choice situations, only that there was a constant input of new choice situations to which the decision maker had the ability to attend. The specific attributes of the original simulation in connection with triggering will be presented in the following section.

One minor modification to the simulation was made, limiting the number of consecutive time periods a participant could work on a given choice to three time periods maximum. The decision maker could return to the choice he was working on, but was forced to divert his attention elsewhere, at least temporarily. In the original model, a participant conceivably could work all 20 time periods on the same choice, if he had access, and the choice remained active in the system. The research evidence presented earlier indicates managers will not continue to work on the same choice, but will either be interrupted or search for interruptions in the system.

C. RESULTS

1. The Original Model

Table IV and Table V provide an historical analysis of participant attention distribution to choices as they entered the system for the first ten time periods of simulation under the three load conditions and two of the decisional structures (unsegmented and hierarchial).

TABLE IV

UNSEGMENTED DECISION MAKER MOVEMENT*

Time Period	Entering Choice Number	Light Load		Mod Load		Heavy Load	
		DM1	DM5	DM1	DM5	DM1	DM5
1	10	10	10	10	10	10	10
2	7	7	7	7	7	7	7
3	9	9	9	9	9	9	9
4	5	5	5	5	9	5	5
5	2	5	5	2	2	2	2
6	3	3	3	3	3	3	3
7	4	4	4	4	4	4	4
8	1	1	1	1	1	1	1
9	6	6	6	6	6	6	6
10	8	8	8	8	8	8	8

*This table tracks the movement of decision makers 1 and 5 for the first ten time periods, under all three load conditions. They are acting under an unsegmented decision structure.

If eligible for a particular entering choice, decision makers rarely prefer the choice they are presently working on (or other choices in the system) to this newly activated choice. Attention is, in fact, brief and fragmented to any one choice. It is interesting to note the decision maker's behavior is

essentially invariant across load conditions. The participant's interest, regardless of load, is to attend to the immediate vice the important (by definition, choice one is the most important, and ten the least important). Perhaps this is why long range planning, which might be most important to the organization is pushed aside as the telephone rings, the subordinate knocks on the door, or the letter demands a response. These results were consistent across access structures, decision structures, and participant energy distributions.

TABLE V

HIERARCHIAL DECISION MAKER MOVEMENT*

Time Period	Entering Choice Number	Light Load		Mod Load		Heavy Load	
		DM1	DM5	DM1	DM5	DM1	DM5
1	10	10	10	10	10	10	10
2	7	7	7	7	7	7	7
3	9	9	9	9	9	9	9
4	5	5	5	5	5	5	5
5	2	2	5	2	5	2	7
6	3	3	5	3	0	3	9
7	4	4	5	4	0	4	9
8	1	[illegible]	5	1	0	1	9
9	6	6	6	6	6	6	6
10	8	8	8	8	8	8	8

*This table tracks the movement of decision makers one and five for the first ten time periods, under all three load conditions. They are acting under a hierarchial decision structure.

NOTE: 0 means unattached, no choices are in the system for which the participant is eligible.

2. Modification

Limiting the time a decision maker could remain with a single choice situation had little effect on the overall simulation results as shown in Table VI, except in certain cases under moderate load (see Table VII).

TABLE VI

ORIGINAL SIMULATION vs. ATTENTION RESTRICTION MODIFICATION*

		Original	Modification
Light Load	Choice Failures	.4	.4
	Problem Failures	8.0	7.9
Moderate Load	Choice Failures	1.0	1.4
	Problem Failures	10.5	14.8
Heavy Load	Choice Failures	1.7	1.8
	Problem Failures	16.1	16.1

*This table compares the mean choice failures (ten maximum) and mean problem failures (20 maximum) for all three load conditions, between the original simulation and the attention restriction modification.

TABLE VII

MODERATE LOAD DEGRADATION*

Access Structure	Decision Structure
Unsegmented	Unsegmented
Unsegmented	Hierarchial
Hierarchial	Hierarchial

*Organizational variants with significant degradation in problem solution between original simulation and modification under moderate load.

Under light load, problems are easy enough (1.1 units of energy per problem) that participants can be diverted from a choice they are dilligently working on, and still return to make the choice and solve associated problems. Heavy load decision making follows the same pattern in the modification as with the original simulation--choices are hard to make and most problems remain unsolved.

It is only under moderate load where some variation occurred, and only with three combinations of structures. In comparing the decision making histories, one can see why there exists such a wide disparity in results for these structures. Under the normal simulation conditions, each of the structures at the bottom of Table VI make a single unimportant choice in a very late time period, solving up to 16 problems at once. This occurs because a large number of decision makers and problems float to a single choice about time period 11, allowing other choices in the arena to be made by flight or oversight. This large migration occurs because an unimportant choice can be accessed by everyone under unsegmented structures, and by most problems and participants under hierarchial. These decision makers and problems then battle each other within this single choice, for a number of time periods, with the participants finally accumulating enough energy to make the choice and solve the problems, late in the game.

When the participants must break their attention, as modeled in the modification, and are not allowed

a consistent buildup of energy, they never attain the required strength to overcome the problems.

D. IMPLICATIONS

1) Triggering has been shown, through field research and historical analysis, to be a very real and important part of organizational life. The garbage can simulation operates in an arena where triggering and fragmentation of decision maker time, energy, and attention are prominent attributes affecting how decisions are made or not made.

This is a strong indication of the broad application of garbage can-like decision making beyond educational institutions and irregular organizations. In addition, the model has demonstrated its potential to serve as a foundation for further studies of triggering and its effects.

2) Since it is apparent that individual decision makers do not have a strong desire to limit triggering, an organization, through its structural definitions, may artificially place restrictions on choice situations being created for specific decision makers, or at least limit the influx of problems to particular choices.

Under an unsegmented decision structure, for example, participant five will normally attend immediately to any entering choice, one through ten. When the decision structure is changed to hierarchial, participant five will still attend to entering choices, but now only choices five

through ten will divert his energy when they are activated. When choice one through four enter, however, participant five will not attach to these choices, thereby providing the decision situation he is presently working on with more concentrated effort.

3) Looking at the process of triggering from the vantage point of the superior, subordinate, or outsider who caused the trigger and forced the decision situation, they can be confident that their interest is at least being studied, even if only briefly, by eligible decision makers. The garbage can indicates numerous issues can be approached, and at least under light and moderate load, decisions are made on these issues, and some attendant problems are being solved.

4) If triggering and associated participant reaction is proceeding as expected, i.e., the organization is operating similar to the garbage can model, organizational participants should be encouraged to limit their time at any one choice. This idea is in direct opposition to the concepts of time management, where interruptions and diversions are to be avoided. If a cost is not associated with moving from choice to choice, i.e., "start-up" costs with a new choice or memory loss when returning to an old choice, a decision maker can fragment his attention to allow the broadest coverage of organizational issues, without degrading system performance in decision making

or problem solving. The exception to this is when a large number of decision makers have been involved in a single choice situation for some time, with the potential to resolve a number of problems. Under those circumstances, it is better to allow the group to continue to devote concentrated time and energy, rather than place restrictions on their attendance.

IV. DEADLINES

A. DISCUSSION

Deadlines, as an organizational occurence, are not discussed in the original garbage can article, but their potential for existence under conditions of ambiguity is broached in March and Olsen's Ambiguity and Choice in Organizations [Ref. 11: p. 226]. Intuition tells us even when goals are unclear, decision making technology undefined, and decision maker participation inconsistent, personal and organizational deadlines will still be present and have an effect on attention allocation and decision attainment.

In his analysis of Roosevelt, Truman, and Eisenhower during their terms of office in the White House, R. E. Neustadt highlighted the importance of deadlines:

> A President's priorities are set not by the relative importance of a task, but by the relative necessity for him to do it. He deals first with the things that are required of him next. Deadlines rule his personal agenda. [Ref. 36: p. 50]

Similar results were observed by Sune Carlson. His studies of Swedish managing directors found them to be driven by their personal appointment books; if someone was interested in getting a director to attend to an issue, the commitment had to be documented on their calendar for a specific date and time. [Ref. 37: p. 71]

1. Soft vs. Hard Deadlines

Progress report sumbissions and material shipment in business, major military operations such as the Inchon landing in the Korean War, and the budget process in the government--all are associated with deadlines. Often these deadlines prove to be "soft" in that the project continues even though not completed by the supposed deadline. The United States Congressional budget enactments of the last few years are good examples of this situation. In other circumstances, however, the organizational system is unyielding in its demand for a resolution by a definite date or time. For instance, if a certain product is not shipped by an agreed upon date, a contractual penalty may be imposed, or the contract lost. It is this second type of deadline, the "hard" deadline, which will be studied and simulated under a number of conditions.

2. Individual Response to Deadlines

In examining accounts of those who have faced and observed deadline and crises situations, it becomes apparent that individuals do not react in identical ways to these time-pressured conditions. Observing the decision process during the Cuban Missile Crisis, Robert Kennedy concluded:

> That kind of pressure does strange things to a human being, even to brilliant, self-confident, mature, experienced men. For some it brings out characteristics and strengths that perhaps even they never knew they had, and for others the pressure is too overwhelming. [Ref. 32: p. 44]

General Abraham Adan, a Division Commander during the 1973 Arab-Israeli War, related similar experiences:

> At times of crisis, particularly in wartime, everyone is expected to outdo himself and exploit his abilities to the full. Some break when the responsibility is intolerably heavy. [Ref. 29: p. 453]

These and other accounts of reactions to deadlines would indicate decision makers basically fall into one of two categories when facing a deadline: those who thrive on the challenge of a deadline, mobilizing extra energy as a byproduct, and those who regress in their ability to cope with the situation, seeing the deadline more as an obstacle than a motivator.

3. Added Energy to Deadlined Choices

Although both types of decision makers would exist in any organization, the study of deadlines was simplified by first concentrating on the circumstances where the organizational system reacted in a positive way to deadlines, potentially providing additional energy to the decision process. This additional energy increase to the system is deemed possible in crisis situations for short periods of time, as evidenced by all night meetings of key executives or legislators, extended rescue work by firefighters during a disaster, and military personnel engaged in a battle spanning several consecutive days. Three models were tested:

1) Deadlines on choice situations (forced attachment)-- The system and/or its environment create a deadline on a

specific choice situation, and all eligible participants, as determined by the organizational structures, devote their time, energy, and attention to this decision, remaining with the choice until completed or deadlined without solution. This deadline draws participants to the choice due to some type of penalty and reward associated with the choice outcome, but the participants are not able to provide more than their normal amount of energy or attention to the deadlined choice. Deadlines commonly force decision makers away from other commitments, enabling them to devote their full energy to the task at hand [Ref. 11].

2) Deadline on choice situation (natural attachment)-- Once again the system and/or environment create a deadline on a specific choice situation, but this time, only those participants coming to this decision opportunity by natural occurence of events, i.e., through the flows and interaction of decision makers, problems, solutions, and choices, remain working on the choice. The system does not impose a requirement for participants to assist in the decision making situation, but if a decision maker happens to wander in, he or she stays at the choice, ignoring other decision opportunities, out of obligation, organizational rules, or peer pressure.

This type of deadline response will occur under conditions of low organizational communications, where participants do not learn about the deadline penalty

or reward structure until they arrive at the choice opportunity.

3) <u>Deadline on choice situation</u> (additional participant energy)--There is a deadline, but no associated continuous attachment to that choice situation. Instead, any participant who works on the deadlined choice at any time is able to provide more energy toward solution than he or she would if it were just a normal decision situation. The attached participants are, therefore, ones who benefit from the challenge of a deadline.

4. Secret Deadlines

Another set of deadline circumstances was examined, and has been entitled "secret" deadlines. The deadlines are "secret" in the sense they are totally unknown to the organization, or at least unknown until their occurence, and therefore do not provide for the effects modeled in the previous section like added energy or forced participant attention. Three types of secret deadlines were modeled:

1) <u>Secret deadlines on choices</u>--The organization is faced with a deadline, but because of various reasons, (i.e., the deadline is assumed "soft" when in fact it is "hard", or the decision makers have learned to react to deadlines with caution since so many end up evaporating) no special adaptations are made to assist the choice to completion. The system is allowed to interact as normal, but if the marked decision situation reaches its deadline, it disappears without any future opportunity for solution.

2) Secret deadlines on problems--This is a different look at deadlines in that instead of choice situations having the potential to evaporate without consummation, now problems are the ones that disappear at a certain point in time. Having problems leave the arena should help the overall system in solving the remaining problems.

Do organizational problems really disappear like this? They certainly do. Incorrectly analyzed data can have decision makers thinking they have a problem, even devote energy trying to solve it, only to find out over time that the situation is not really a problem after all. Deception in combat is a good example of this. A false radar blip might have an air defense unit alerted, ready for action, and find out only through time that their supposed contact, or potential problem, has left the scope, never to affect the unit again.

3) Secret deadlines on participants--This again is a different twist to the subject of deadlines. In studying a relatively closed organizational system, i.e., the simulation of ten decision makers in an arena, the loss of one participant has the potential to hurt the decision making ability of the group significantly. This is the ultimate case of fluid participation when decision makers are not only moving from choice to choice, but actually are leaving the arena. Mortalities and communication failures in combat, i.e., deadlines on participants, lead

to the extinction of certain energy, potentially available for contribution by the affected participants. The movement of qualified consultants and retiring executives out of an organization presents similar energy loss problems to the business world.

B. SIMULATION

An explanation of the six separate deadline simulation modifications is presented below:

1) Deadline on choice situation (forced attachment)--During the initialization process of the simulation, a random number generator is used to select one of the ten choices to be deadlined. When that choice enters the system, it is tagged to be ejected after four time periods unless, of course, the choice can be made before the deadline.

The other event occurring when the deadlined choice enters the system is that every eligible participant, as determined by the current decision structure, is attached to this choice. This attachment of participants remains effective until the choice is consummated, or the deadline occurs. At the point the choice disappears--for either of the above two reasons--the participants and any attached problems become eligible to move to other choices. Problems, unlike participants, are not required to migrate to the deadlined choice.

2) Deadline on choice situation (natural attachment)--The same initialization procedure is accomplished as in the modification one, but when the deadlined choice enters, no one is forced to this particular choice. If, however, at any time a participant attaches to the deadlined choice, that participant must remain there until the choice is again either made or deadlined. Participant and problem detachment is handled in the same manner as modification one.

3) Deadline on choice situation (additional participant energy)--Initial set-up is the same, but participants are not forced at any time to attach to the deadlined choice. When a participant does happen to enter the deadlined choice, he is given .55 extra units of energy to provide to that decision situation. (.55 equals one-tenth the total energy available to all ten participants.) This additional energy is only provided for participants working on the deadline.

4) Secret deadline on choices--Once again, initial set-up is the same as modification one, but in this case the system is allowed to operate as it normally does, with the exception if the selected choice is not made by the deadline, it is ejected from the system and counted as a choice not made.

5) Secret deadline on problems--A problem is selected at random to be deadlined four time periods after entrance. If the problem remains unsolved at the point of deadline,

the problem departs the arena, never to return. No special considerations are made for this deadlined problem, and other problems, choices, and participants are permitted to interact as usual.

6) Secret deadline on participants--Participants are in the decision arena from the very beginning, therefore the random number generator selects both a participant to deadline, and a time period for him to leave the system. Again, no special adjustments are made for the departure of the deadlined participant. His potential for energy contribution is lost for the time periods remaining after his departure.

C. RESULTS

1. Secret Deadline on Participants

The most straightforward results were obtained from putting a secret deadline on a single participant (modification six). The simulation was run twice with this modification--decision maker three was deadlined in time period eight in the first run, and decision maker seven was deadlined in time period 11 in the second run.

Deadlining participant three (a fairly important decision maker) caused 17 of the 81 organizational variants to degrade significantly as compared to the original simulation. The other 64 variants remained relatively stable. Nine of these 17 degraded structural combinations had an energy distribution where the most important decision maker

had the most energy to provide the system. Degradation occurred over all three load conditions and affected all possible problem and decision access structures. The unsegmented decision structure, however, was the least affected. Only one of the 17 variants had this type of decisional structure.

When decision maker seven was deadlined, fewer organizational variants were affected, and only ten degraded. The same basic results occurred, except five of the ten degradations occurred with an energy distribution where the less important decision makers had more energy. This makes sense since decision maker seven is considered a less important decision maker. Once again, the unsegmented decision structure remained relatively stable through the change.

2. Secret Deadline on Problems

One would think taking a problem out of the arena should improve overall system performance. This is generally, but not always the case. One run was accomplished deadlining problem one, another run deadlined problem three. The first instance resulted in 70 organizational variants performing relatively the same as the original simulation, eight variants significantly improving, and three variants actually degrading. The deadline on problem three produced comparable results.

Degradation occurred only under hierarchial problem access in combination with either specialized or hierarchial

decision access. The disappearance of the deadlined problem caused a rearrangement of subsequent problem flows to choices, keeping important problems at important choices. In the original simulation, these important problems fled to an unimportant choice situation, later to be solved by resolution. In the modification, with the combination of a group of important problems at an important choice and a limited ability of decision makers to provide energy to this choice, both choice and problem failures resulted.

3. Secret Deadline on Choices

This modification was run once, deadlining choice four. Sixteen of the 81 variants demonstrated decreased performance relative to the original simulation. This was due primarily to the situation in the original simulation where choice four was made by resolution after time period 11 (the deadline period in the modification). Losing a choice situation leads to the possibility of a more intense buildup of problems on remaining choices in the system. Because of this fact, the unsegmented decision structure, with its inherent flexibility and reserve of potential energy, did not experience any deterioration when choice four was removed. In fact, under the secret deadline condition, the combination of moderate load, hierarchial access structure, and unsegmented decision structure actually improved system performance. This was the only variant which experienced an improvement. All of the others either degraded or experienced little change.

4. Forced and Free Attachment to Deadlined Choice

The first observation about these two organizational adaptations to deadlines is that they both achieve the same results. Because of the triggering mechanism, discussed in Chapter III, when a choice enters the system, eligible participants inevitably turn their attention to this decision situation. Therefore, whether the organization forces decision makers to the deadlined choice or allows the garbage can system to operate as normal, participants will be attracted to this entering choice. The difference between the original system interaction and these two modifications is with the adaptation, when the participants attach, they do not leave the choice until it is made or leaves the arena by deadline. This allows a concentrated effort on the "marked" choice.

When a secret deadline is placed on choice four, 27 of the organizational variants experience choice four being deadlined before it can be completed. If one of the two attachment modifications is used on the entering deadlined choice, the choice failures on number four reduce from 27 to ten. Because of the forced attachment, one would surmise the aforementioned improvement would be at the expense of overall system results, but this is not the case. When the attachment modifications are compared to the original simulation, little difference in performance is noted, and when they are compared to the secret deadline

modification, not only is the deadlined choice resolved more often, but aggregate success is improved.

5. Adding Energy to Participants

Giving decision makers extra "motivation" energy when participating in a deadlined choice situation has some positive impact in making deadlined choices, but not as much as the attachment modifications. Out of the 27 organizational variants mentioned previously which were unable to make choice four (the selected deadline choice) by the required time, adding energy to participants decreased this failure rate to 19, whereas the attachment modifications reduced it to ten. The primary reason for this is again connected to triggering. Unless forced to remain at a choice, participants will tend to move on to other decision situations, therefore adding energy as a one time boost to decision making does not have a substantial effect.

D. IMPLICATIONS

Deadlines have the potential for being an important control mechanism in garbage can-like situations. Much more investigation and simulation is needed in this area before significant generalizations can be presented as to how deadlines affect an organization under conditions of ambiguity. The basic simulation provides the solid foundation to examine deadlines, but because of the high degree of interaction and interrelatedness of flows, computerized data analysis is needed to maximize the results of investigation.

Keeping this in mind, four implications are presented based on the simulation modification results obtained:

1) If an organization wants to improve the chances of a specific choice being made, placing a deadline on it, and adjusting decision maker behavior can provide for the achievement of this intention. The modification forcing decision makers to a deadlined choice demonstrated that keeping decision makers working on a deadlined choice rather than allowing them to react to every incoming decision opportunity has great potential for resolving the choice of interest, while not degrading overall system effectiveness. Having motivated participants, contributing extra energy to a deadlined choice, can help also; but if they are not sheltered from the triggering phenomenon, this impact will not be as substantial.

2) When participants and choices are disappearing from the arena because of "secret" deadlines, and the organization has not provided a procedure for special attention allocation, the unsegmented decision structure allows for retained stability. Because of the power of mass movement with a high energy potential and the flexibility of accessing all choices in the arena, it naturally is able to adapt to changing circumstances.

3) For the most part, organizations should rejoice over the occurence of problems leaving the arena, but as highlighted by the secret deadline on problems modification,

because of the garbage can interaction process, decision makers must be aware how the system readjusts to this event. The readjustment effort may result in unusual, unanticipated, or pathological results.

4) When decision makers, for whatever reason, leave the arena without replacement, the overall system is going to be hurt. Since an organization does not know which participants might depart, the secret deadline on participants modification shows it is helpful to have as even a distribution of energy as possible among decision makers. This can be accomplished through shared information, education and training, and other methods to allow a common group of decision makers to have the same potential for energy contributions to a specific decision situation. Losing a single decision maker, therefore, will not have the devastating effect that would be experienced if, for instance, the organization had an energy distribution where the most important decision maker had the most energy, and the number two man was lost, destroying a significant future energy contribution potential.

V. DYNAMIC SYSTEM LOAD CHANGE

A. DISCUSSION

The system load factor in the original garbage can simulation is based on the energy required to solve problems entering the organization. Under light load, each of the 20 problems requires 1.1 units of energy for solution. Moderate load increases this factor to 2.2, and heavy load to 3.3. Considering the fact that participants consistently provide the system with a maximum of 5.5 units of problem solving energy per time period (deflated by the solution coefficient), the slack available in the organization decreases as the load increases. A particular load condition is kept constant for all 20 time periods, for all 81 organizational variants. This consistency of load would be an accurate representation of reality when a short time horizon was associated with the 20 periods. Expanding this time horizon would necessitate a dynamic change in the load, particularly if one were modeling military units approaching the enemy in combat, or a business/political organization facing a growing crisis.

An overall system load increase has historically been associated primarily with the effect of information on decision making and problem solving. The organizational decisional system has been compared to a communications net

with varying types of information entering the system, and subsequently being stored, processed, and distributed [Ref. 28: p. 128]. Even under stable organizational circumstances, this net produces distortions and erroneous information. A rapidly changing environment will create even greater informational difficulties for the decision maker. Karl von Clausewitz, military strategist, has identified the information problem in times of complexity and uncertainty for the military commander: "A great part of the information in war is contradictory, a still greater part is false, and by far the greatest part is somewhat doubtful." [Ref. 13: p. 128]

Facing significant decisions, and attempting to solve perplexing and time critical problems often leads to an intense search for information [Ref. 15: p. 78]. For example, President Kennedy continued, as the Cuban Missile Crisis proceeded, to increase the number of low level reconnaissance flights over Cuba, hoping to ascertain more accurate and timely information on the Soviet missile sites [Ref. 32]. This accelerated search for information can lead to an information stress condition identified by Miller in Living Systems, known as input excess or overload [Ref. 16].

This overload is occurring as decision makers are inquiring of sources outside the formal lines of authority (as suggested by Mintzberg [Ref. 24: p. 70]) and receiving advice from "every specialized unit at every level of the

hierarchy" [Ref. 15: p. 78]. This abundance of information is difficult for the decision maker to process, and often results in poor decisions or other operational inefficiencies [Ref. 16: p. 159].

Miller presents two other varieties of information stresses: noise in the system, and information input lack or underload. A description provided by General Abraham Adan of the Israeli Army's Southern Command Headquarters during the 1973 Arab-Israeli War vividly represents the effect of noise:

> The war room was jammed with staff officers and visitors. The place was a mess; you could barely find your own feet. Looking at the maps and listening to transceivers, I tried to follow reports from our forces along the front, but in vain. So deafening was the noise in the room, and so distorted the sound from the radio net that it was impossible to understand anything. It was a frustrating and depressing situation. I could not help thinking that it had to be impossible to work out any coherent plan amidst such disorder. [Ref. 29: p. 95]

Confusion reigns supreme, and information, even if accurate and beneficial, never seems to reach the appropriate decision maker.

Limited information can, of course, also be harmful to organizational effectiveness. A crisis-like situation, coupled with little intelligence data, or possible alternatives, makes problems appear more difficult and decisions addressing these problems nearly impossible to resolve.

Information (too much, too little, or too noisy) is a significant factor in establishing the existence of systems

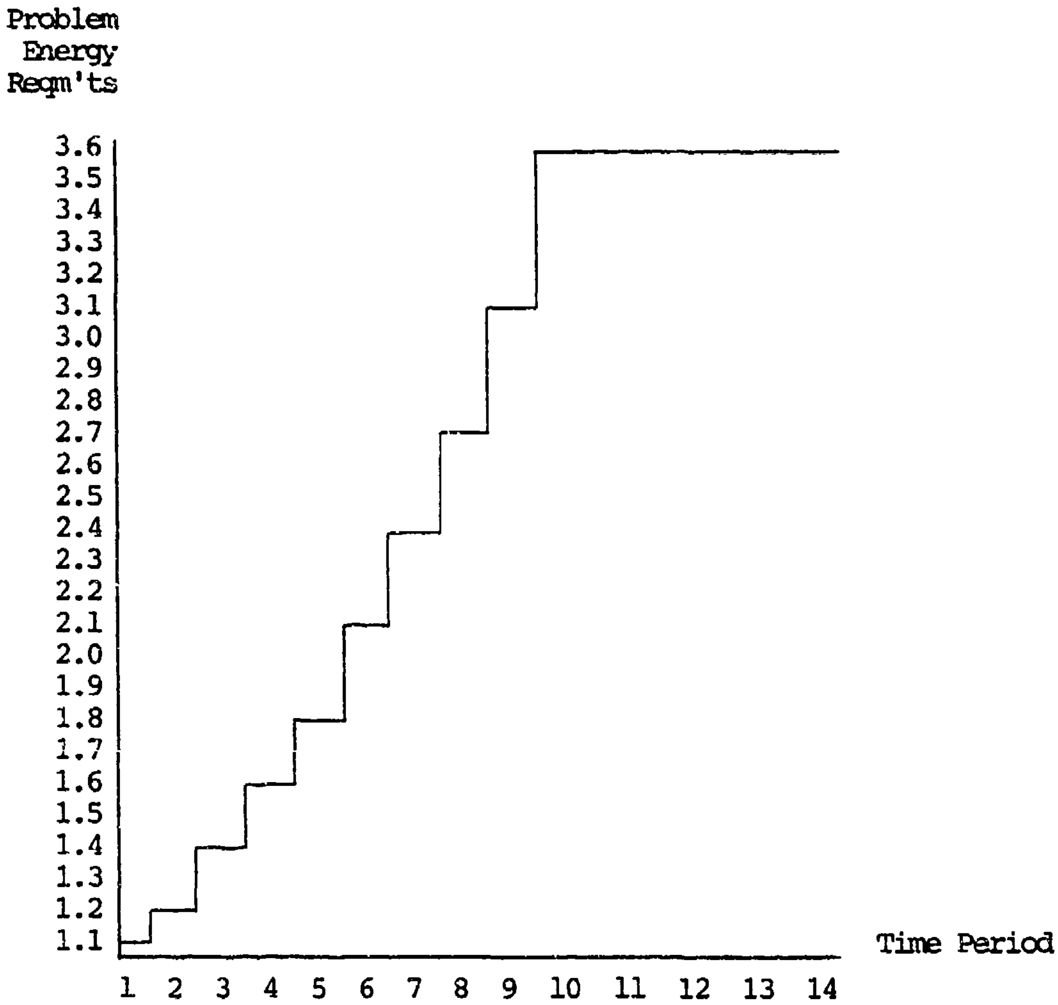
having an increase in load and growing problem difficulty. It is, however, not the only factor. Relative load on a system can increase due to time criticality, fatigue of the decision makers, established plans falling into disarray, or unexpected events occurring due to accidents, natural disasters, or competitor actions. Although the reasons are many and varied, the reality is one or a combination of these factors leads to a condition where the load on a system increases dramatically, making decisions and problems hard to bring to conclusion.

B. SIMULATION

The original simulation uses a 20x1 matrix, initiated at the beginning of the program, to a sign the energy requirement for all 20 problems. For example, if the energy load for a particular run was moderate, the matrix would be filled with 2.2, and in each of the 20 time periods, a problem's energy requirements would be taken from this matrix to be 2.2.

The simulation was modified so the matrix was dynamically changed at the outset of the first ten time periods to represent an increase in load. Figure 5.1 graphically depicts the change in problem energy requirements.

The simulation was then run through each of the possible organizational variants, and results tabulated and presented in the next section.



This figure plots the problem energy requirements over the first 14 time periods, as modeled by the simulation modification.

Figure 5.1 Dynamic Load Increase

C. RESULTS

Table VIII summarizes the results, comparing the running of the original simulation to the modified version with dynamic load variation (choice, problem, and solution coefficient streams were the same for both runs).

TABLE VIII

ORIGINAL SIMULATION vs. DYNAMIC LOAD MODIFICATION*

Original

Load	Mean # of Choice Failures	Mean # of Problem Failures	% Choices by Resolution
Light	.4	8.0	48
Moderate	.96	10.5	36
Heavy	1.7	16.1	25

Modification

Mean # of Choice Failures	Mean # of Problem Failures	% Choices by Resolution
1.7	14.9	33

*This table presents how the modification compared to the original simulation (under all three load conditions) in the areas of choice failures (out of ten maximum), problem failures (20 maximum), and % of choices made by resolution.

Varying the load in the manner presented in the last section creates an overall result falling in between a constant moderate load and a constant heavy load. This is in spite of the fact the problem's energy requirements are 3.6 for periods 11 through 20 for the modification, compared to 3.3 for the original simulation under heavy load.

The modification did not significantly affect the triggering mechanism of participants attaching to incoming choices (as described in Chapter III), but it does affect the attachment procedures for the time periods after choices no longer enter (periods 11 through 20). A different

pattern of organizational movement of participants and problems among choices is evident.

Another set of results was evaluated at the completion of exercising the modification--the time period distribution of problem solution, comparing the modification to the original simulation. The participants in the modified version took advantage of the initial lighter load, in periods one through five, and took care of 50 percent of the eventual problems solved. This is compared to the original simulation, where under light load the participants used periods one through five to solve 27 percent of the eventual problem successes, under moderate load 20 percent, and under heavy load 24 percent. Periods six through ten for the modification experienced only 2 percent of eventual problem solutions--participants had a very difficult time consummating problems during this intense time of load increase. In comparison, the original simulation used periods six through ten to solve 22 percent (light load), 11 percent (moderate load), and 10 percent (heavy load) of the eventual problem solutions.

One would conjecture that the results obtained with this load increase modification are more representative of aggregate system performance, when modeling a dynamic crisis-like environment, than the outcome associated with any one of the three static load conditions. The significance of these results are presented in the following section.

D. IMPLICATIONS

1) The garbage can simulation has the flexibility to incorporate the enhancement of a dynamic load variation. Many variations of this change in load could be studied to determine interaction specifics for organizations faced with ambiguity and increasing problem difficulty.

2) An organization will make choices more consistently and solve a greater number of problems if the load on the organization is kept to a minimum, i.e., a light or moderate load.

3) Since it is for all practical purposes impossible to prevent load fluctuations, an organization can take some steps to ease the trauma of dramatic increases in load where problem difficulty becomes magnified:

a) Solve as many organizational problems as possible before the load begins to increase rapidly. If there is organizational slack available in early stages of a crisis, use the slack to concentrate on any problems in the arena at that particular time. This will allow decision makers to ride out the load increase, and then solve more problems as the load level steadies out, even if this level is one where problem difficulty is extremely high.

b) If additional participants can be added to the system, providing extra attention and energy to decision making and problem solving, they should be

injected into the system at the point where the load is increasing rapidly. This is the time frame when the system is having the most trouble bringing problems to solution. This will require the organization to anticipate this imminent condition, and plan for personnel selection and augmentation before the actual occurence of dramatic increase in organizational problem difficulty.

c) Different adjustment processes for information overload are presented by Miller in Living Systems [Ref. 16: p. 123]. Organizations faced with a dynamic load increase can selectively choose a combination of adjustments leading to a better control over information. For instance, using filtering to process only certain high priority messages or having multiple channels to decrease the load on a single decision maker may lead to more successful problem solving. [Ref. 16: p. 159].

d) Flexible plans with multiple contingencies can provide a more programmed response to unexpected events, which normally would overload the system. The distinct advantage of flexible planning is that development of these plans can be done during times of light load, when decision makers will have more time and energy to devote to creativity and reflection.

4) There appears to be certain access and decisional structures which are more stable under increasing load conditions, or certain combinations of structures which could be used dynamically in a changing environment. The investigation and results in this area are presented in the following chapter.

VI. DYNAMIC STRUCTURAL CHANGES

A. DISCUSSION

The dynamic load increase modeled in the last chapter is an occurence every type of organization must face. How an organization and its decision makers confront this crisis situation may well determine their survival. As discussed in the preceding chapter, flexible and well-developed plans can contribute a great deal toward successful organizational adaptation under these uncertain and unpredictable conditions. von Clausewitz, commenting on the subject of military planning, however, has rightly identified the shortcomings of strategies and plans. His thoughts hold true for any organizational system facing the ambiguity of crisis:

> Strategy develops the plan of the war. . . . it plans the separate campaigns and arranges the engagements to be fought in each of them. Since these are matters which, to a great extent, can only be based on assumptions, and some of these turn out to be incorrect, while a number of other decisions pertaining to details cannot be made beforehand at all, it is evident that strategy must accompany the army to the field in order to arrange particulars on the spot, and to make the modifications in the general plan which constantly becomes necessary. [Ref. 13: p. 171]

As vital as plans may be, other organizational procedures must be used in conjunction with planning to adjust to the increasing load experienced as a military unit goes into combat, or an organization faces an escalating crisis.

Changing organizational structure as a response to a turbulent environment has been suggested by Lawrence and Lorsch [Ref. 38]; Galbraith [Ref. 39]; Hedberg, Nystrom, and Starbuck [Ref. 40]; Allison [Ref. 1]; and Sproull, Weiner, and Wolf [Ref. 9]. Allison has pointed out that major crises, in fact, become an excellent opportunity to enact dramatic organizational change [Ref. 1]. One observation made of organizations making such a structural change during a crisis is that decisional units tend to be smaller, more participative, and less formal, at least while the crisis is ongoing [Ref. 27, Ref. 28, Ref. 32].

The original garbage can simulation results hint at the potential profitability in changing structures as system load increases. Table IX lists the three organizational variants which best made choices and solved problems under the three load conditions, and for comparison shows the mean choices made and problems solved over all variants for that particular load condition.

One notices that the same combinations are not found consistently through all loads. Unsegmented-Unsegmented, and Hierarchial-Hierarchial are front-runners under light and moderate load, but are not even in the top three under heavy load. What is especially interesting to note is the emergence of the specialized access structure as a successful variant when the load begins to be a significant factor.

TABLE IX

SUCCESSFUL ORGANIZATIONAL VARIANTS

	Access Str	Decision Str	Choices Made	Problems Solved
LIGHT	Unseg	Unseg	10.0	20.0
	Hier	Hier	10.0	17.3
	Hier	Unseg	10.0	17.0
	MEAN over all variants		9.6	12.0
MOD	Unseg	Unseg	10.0	20.0
	Hier	Hier	10.0	18.3
	Spec	Unseg	10.0	11.0
	MEAN over all variants		9.0	9.5
HEAVY	Spec	Unseg	10.0	11.0
	Hier	Unseg	9.0	8.0
	Spec	Hier	8.0	8.0
	MEAN over all variants		8.3	3.9

*These structural combinations are averaged over all three energy distributions.

The increasing load simulation modification, as presented in the last chapter enables a study of whether structural change can, in fact, improve organizational performance in times of expanding ambiguity and complexity. For as Cohen and March stated in Leadership and Ambiguity:

> "Management" in an anarchy involves the substitution of knowledge and subtle adjustment (emphasis is the author's) for the explicit authoritative control of bureaucracy. [Ref. 10: p. 39]

B. SIMULATION

The objective of the structural change simulation study was determining the profitability of manipulating

either the access or decision structure as the system load increased. Would organizational performance be optimized with fixed structures, i.e., keeping an unsegmented decision structure with an unsegmented access structure for all 20 time periods, or would the system benefit from fixing one type of structure and transitioning the other, i.e., keeping an unsegmented decision structure, but transitioning from an unsegmented access to specialized access structure as the load increased? This second method presumably would take advantage of the differing performance abilities of the various structures under the original simulation's three load conditions.

Six different structural transitions were examined, as summarized in Table X.

TABLE X

STRUCTURAL TRANSITIONS STUDIED

Fixed Structure	Transition Structures
Unseg Access	Unseg Decision to Hier Decision
Hier Access	Hier Decision to Unseg Decision
Spec Access	Spec Decision to Unseg Decision
Unseg Decision	Unseg Access to Spec Access
Hier Decision	Hier Access to Spec Access
Spec Decision	Spec Access to Unseg Access

Each of the possible access structures were kept fixed, and a change was made from one decision structure to another (the methodology used for deciding which structures to

transition is given below). The same procedure was used keeping each of the decision structures fixed and altering the access structure. Only one structural change was made per modification, and changing both access and decision structures at the same time was not attempted.

For each modification study, the starting structural combination was based on optimal results obtained under light and moderate loads (in the original simulation), and the transition structural combination was based on successful results obtained under heavy load (again from the original simulation). Taking the unsegmented decision structure as an illustrative example: under light and moderate loads in the original simulation, this decision structure, combined with an unsegmented access structure, is able to solve more problems and make more choices than the combination of unsegmented decision with hierarchial access or specialized access. Under heavy load, however, the best structure to combine with unsegmented decision is a specialized access--so this was chosen as the transition structure. Similar logic was used for the other five modifications.

Experimentation was done on the time period of transition for each of the modifications to determine the optimal interval to make the structural change.

C. RESULTS

The results imply there is, in fact, a structural transition achieving superior system performance. The

unsegmented decision structure, with a transition from an unsegmented to a specialized access structure, outdoes any other possible combination, fixed or transitioned, when the system is facing an increasing load condition. In fact, this modification achieved 80 percent of its choices by resolution--a result unparalleled by any organizational variant, even under light load with the original simulation.

Table XI compares, by way of choices made and problems solved, this unsegmented to specialized access transition to the next best transition structure, to the three best fixed structures under dynamic load, and to the mean results for the dynamic load condition averaged over all variants.

TABLE XI

DYNAMIC STRUCTURAL CHANGE RESULTS

Access Str.	Decision Str.	Choices Made	Problems Solved
Unseg to Spec	Unseg	10.0	14.0
Spec	Spec to Unseg	9.7	11.7
Spec	Unseg	10.0	11.0
Hier	Unseg	9.0	9.0
Spec	Hier	8.0	8.0
MEAN over all fixed variants		8.3	5.1

D. IMPLICATIONS

1) The simulation, through minor modification, is able to represent the recommended and observed occurence of

structural change in response to load variation. Further research is possible with simultaneous variation in both access and decision structures, multiple changes over the 20 periods, and the use of hybrid structures.

2) The superior results obtained by a specific combination of decision and access structures, transitioned over time, supports the principle presented by Thompson and Tuden in Leavitt and Pondy's Readings in Managerial Psychology, that "an important role for administration is to manage the decision process, as distinct from making the decision" [Ref. 41: p. 511]. When key leaders of an organization are involved in decision making during crises situations, they may be unable to control the actual making of decisions, as problems, solutions, choices, and participants flow throughout the system, but they have the opportunity to manage the process through wise and judicious selection of control and coordination mechanisms. This should provide hope for the key decision makers facing ambiguous organizational circumstances.

3) The simulation results imply that the farsighted organization will use an unsegmented decision and access structure under lighter loads, and move to a specialized access structure as load increases rapidly. The arrangement under heavy load imposes structure on who can raise problems within choice situations, but imposes little structure on who can contribute energy for solution. The

questions that follow this implication are: does this organizational philosophy seem reasonable, and does this type of transition actually occur?

An unsegmented decision structure represents the concept of participative management, multiple organizational actors all having access to the same choice situations. The simultaneous movement of the Flag Officer, his Chief of Staff, and his Operations Officer to decision situations which they attend together, is representative, in the military context, of this organizational structure.

Similar structure and movement can be found in special task forces in the political environment, as well as in business where corporations are using a strategy of positioning more than one key person at the top of the company to ease the burden on a single leading executive. The principle of smaller decisional groups, acting participatively in crisis situations, presented in the discussion section of this chapter, would certainly be modeled by the unsegmented decision structure.

The unsegmented access structure (optimal simulation structure under light and moderate loads) allows problems to have free access to all choice situations. Under lighter loads, this seems very reasonable. If we imagine a staff (military, political, or industrial) working together under light load, they are apt to allow both major and minor problems to enter decisional situations.

The Fleet Admiral, for example, might be discussing minor maintenance problems experienced by his flagship, as well as considering possible enemy strengths, although an engagement is not imminent.

When load increases, however, i.e., contact with the enemy is made, problems must be restricted in their access to decisional situations--the need for a gasket having little bearing on the ability of the task force to engage the enemy will be relegated to a very minor choice situation. There will be a tendency to control problem entrance in a manner that looks much like the specialized access, or at least similar to hierarchial. Because of the continued need for energy, attention, and expertise to be devoted to choices, the decision structure should remain unsegmented through the increase in load.

There are some disadvantages with this dynamic process and the associated structures. First, having an unsegmented decision structure is expensive. Having a well-trained and experienced flag staff costs both time and money, and the same holds true for job sharing at the top of the business organization.

Secondly, Mintzberg found that managers are reluctant to delegate--a technique vital to the success of management by participation. This reluctance is due primarily to their attraction to the verbal media and the subsequent storage of this information in their minds, rather than on paper for the whole organization to use [Ref. 30].

Third, many organizational leaders are not enamored by the concept of participative management, and there are, in fact, real dangers inherent in this type of decision making in time of critical circumstances. As a military author wrote: "A brainstorming group on the front line might encounter difficulty, drizzling ideas under a rain of shrapnel" [Ref. 14: p. 143].

Lastly, knowing when to change access structures is critical to achieving satisfactory results. Key decision makers, therefore, must be extremely sensitive to their environment, sensing that time when load is increasing rapidly, and there is a need for problem access restriction.

Even with these disadvantages, studying this approach to decision making under uncertainty and dynamic load increase can help leaders understand the process better, and know when structural changes should be implemented, as well as how these changes will affect their system.

VII. CONCLUSIONS

A. GENERAL COMMENTS

Two statements in the Cohen, March, and Olsen garbage can model article place perspective on the importance of the research presented in this paper:

> It is clear that the garbage can process does not resolve problems well. But it does enable choices to be made and problems solved, even when the organization is plagued with goal ambiguity and conflict, with poorly understood problems that wander in and out of the system, with a variable environment, and with decision makers who may have other things on their minds. [Ref. 8: p. 16]

> . . . organized anarchies require a revised theory of management. Significant parts of contemporary theories of management introduce mechanisms for control and coordination which assume the existence of well-defined goals and a well-defined technology, as well as substantial participant involvement in the affairs of the organization. Where goals and technology are hazy, and participation is fluid, many of the axioms and standard procedures of management collapse. [Ref. 8: p. 2]

The first assertion acknowledges that a system operating according to the garbage can model is unlikely to achieve optimal performance. Organizational decision makers, though, should be encouraged by the fact that the process does have the potential to make some decisions, even good ones, and dispose of certain problems. Better comprehension of this process by the organizational participants should lead to enhanced system results.

The second statement implies that the study, development, and use of the proper managerial tools under

problematic conditions also can help improve organizational effectiveness.

This research contributes to the understanding of organizational systems as they attempt to operate in an uncertain and ambiguous environment. Triggering and dynamic load increases were studied to determine their effect on the garbage can process, and deadlines and structural changes in choice access were presented as a partial response to the need for managerial control and coordination.

In each of the chapters addressing a simulation modification, implications were presented and will not be repeated here. There are, however, some overriding principles to carry away from this research undertaking:

1) Load has a dramatic effect on system effectiveness; it behooves the organizational decision makers to be sensitive to their load condition, and react accordingly--either by using a reduced load for intense planning and solving as many problems as possible, or making structural adaptations to an increasing load condition.

2) Triggering is a process which significantly affects the attention allocation pattern of participants. It is not an inherently bad process, in fact, it permits a diverse portfolio of issues to be addressed, and some may even be resolved. The problem emerges when there are certain critical choices that must be made, and the

resulting fragmentation of decision maker time, energy, and attention often prohibits the desired choice resolution. This is where structural design or deadline adaptation can be used effectively to focus the organization on the proper priorities.

3) Attempting to develop and implement new and unconventional control mechanisms for use in the garbage can process may not be as fruitful as using established tools, adapted to fit the unique characteristics of ambiguous circumstances. In fact, organizational performance may be improved most notably by just having the decision makers better understand the process that is affecting their ability to make decisions. As Mintzberg has said:

> . . . the manager's effectiveness is significantly influenced by his insight into his own work. His performance depends on how well he understands and responds to the pressures and dilemmas of his job. Thus managers who can be introspective about their work are likely to be effective at their jobs. [Ref. 30: p. 60]

B. FUTURE RESEARCH

The simulation experimentation accomplished in this study demonstrated the usefulness of the garbage can model as a springboard for launching future research in a number of areas critical to organizational decision making:

1) How does the flow of organizational information, in which problems and solutions are embedded, affect the interaction of the garbage can elements, and how, in turn, does this ultimately affect decision effectiveness?

2) What is the impact of competition in the scenario of uncertainty, when the system opponent is operating under similar circumstances?

3) Can a learning curve be associated with the decision maker's ability to make choices and solve problems, even under conditions of unclear goals and technology?

4) What is the effect of a mix of both programmed and nonprogrammed decisions in the organizational system?

5) Besides deadlines and structural changes, what management techniques can be used within the garbage can process to direct attention and achieve substantial solution of organizational problems?

In any case, simulation trials should be supplemented by field research and case analysis, where studies of the actual operation of the garbage can process in a cross-section of organizations is compared to the behavior predicted by the enriched model.

There exists a continuing need to study organizational systems as they face the uncertainty of the future, whether this organization be a military unit engaging enemy forces in combat, a business entity confronting a precarious economy, or a government challenged by an international crisis. The garbage can model of organizational choice offers a valuable framework for this understanding, providing the potential payback of improved understanding of organizational decision making, and insight into the means to support this process.

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